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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/SE97/01658 <b>(22) International Filing Date:</b> 3 October 1997 (03.10.97)  <b>(30) Priority Data:</b> 9603757-7 15 October 1996 (15.10.96) SE  <b>(71)(72) Applicant and Inventor:</b> JOHANSSON, Gert [SE/SE]; Kohlsva Gjuteri AB, P.O. Box 101, S-730 30 Kolsva (SE).  <b>(74) Agent:</b> BERGGREN, Björn; Långrevsgatan 1, S-723 49 Västerås (SE).		<b>(81) Designated States:</b> JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>In English translation (filed in Swedish).</i>
<b>(54) Title:</b> METHOD OF MANUFACTURING OBLONG CAPSULES  <b>(57) Abstract</b> <p>The present invention relates to a method of manufacturing oblong canisters for storing spent nuclear fuel elements. This method is characterized in that a bundle of tubes (2) the length of the canister are joined together to form a parcel, by means of welding for instance, around which parcel a casing (9) of metal is cast.</p> <div data-bbox="997 1142 1344 1604" data-label="Image"></div>		

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Method of manufacturing oblong capsules.

**Technical field:**

The present invention relates to a method of manufacturing oblong  
5 canisters for storing spent nuclear fuel elements.

**Background art:**

Casting long objects with internal cavities while retaining the  
straightness of the cavities is problematical. This applies particularly to  
10 canisters for storing spent nuclear fuel elements. When complete such  
canisters shall be sealed at the ends and surrounded by an outer casing  
of copper. This is a method known per se, but it is important that the  
cavities in the canisters are straight. Furthermore, the casting may not  
be too complicated and thus expensive.

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**Description of the invention:**

The method according to the invention aims at solving these problems  
and is characterised in that a bundle of tubes the length of the canister  
are joined together to form a parcel around which a casing of metal is  
20 cast. According to this method sand cores or other types of nuclear  
material are replaced when the cavities are cast. Straight cavities are  
obtained in a simple and efficient manner. Tubes having square or  
round cross section or tubes of some other cross section may be used in  
the parcel to be joined together, by welding for instance.

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In a suitable embodiment, for instance, twelve square tubes are used  
which are joined together and fixed in the desired grouping, by welding  
for instance, or bracing between the tubes, after which the tube parcel is  
filled with filler as required, e.g. ladle lining, and pre-heated. The pre-  
30 heated tube parcel is placed in the lower part of a casting mould and the  
other parts of the mould are positioned, after which casting of the  
casing is performed in vertical position, or horizontal position if its size  
permits, and with casting gates at different levels, for instance. The  
metal used is steel SS 1306, for instance, or some other material. The  
35 canister shall be long, having a length:diameter ratio of between 3:1 and

6:1, but other ratios are also possible. Equipment can be built for extreme proportions.

5 One advantage with the method is that strict straightness tolerances or other tolerances for the canister can be obtained and, of course, that the canister can be produced at all. The requirement (in the case of square tubes) may be that a gauge with dimensions 153:153:4500 shall be passed through the cavity of the canister.

10 The finished canister shall primarily be used for storing spent nuclear fuel elements or other material and shall be sealed all around and at the ends in known manner with an outer casing of copper.

**Brief description of the drawings:**

15 The method according to the invention is exemplified in the accompanying drawings. Figure 1 shows a longitudinal section of a canister to be cast and Figure 2 shows the same canister in cross section. Figure 3 shows a cross section through a parcel of square tubes.

20 **Description of embodiment:**

Figures 1 and 2 show a finished canister, in this case a parcel of twelve square tubes (2) which have been welded together to a parcel and filled with filler, after which pre-heating may be performed if necessary. The ratio between the canister length (L) and its diameter (D) is here 4.9:1.

25 When the fuel elements have been placed in the canister it shall be surrounded by an outer casing of copper (1) and end pieces of the same material.

30 The welded parcel of tubes (Figures 1 and 2) is placed upright and fixed in the lower part or core of a casting mould. The other parts of the mould are positioned and the casting in steel is performed in vertical or horizontal position, e.g. through casting gates at different levels. The material of the tubes is normally steel, SS 1312, and the casting is performed in steel with a wall thickness of 10 mm. When the casting  
35 body has cooled the ladle lining is emptied out. One or more casting

gates can be used at one or more levels, determined by casting weight, dimensions, etc.

Figure 3 shows the square tubes and the straight cavities (2) with  
5 bracing (5) welded between the tubes (2). After insertion of the  
elements the canister is enclosed in copper in known manner.

The method according to the invention can be varied in many ways  
within the scope of the following claims.

## CLAIMS

1. A method of manufacturing an oblong canister for storing spent nuclear fuel elements, characterized in that a  
5 bundle of tubes (2) the length of the canister are joined together to form a parcel around which a casing (9) of metal is cast.
2. A method as claimed in claim 1, characterized in  
10 that a number of tubes (2) are welded together as bracing (5) between the tubes, after which the parcel of tubes is filled with filler, e.g. ladle lining, and pre-heated if necessary.
3. A method as claimed in claim 2, characterized in  
15 that the pre-heated tube parcel is secured in the lower part of a casting mould and the other parts are positioned, after which casting of the casing is performed in vertical position.
4. A method as claimed in claims 1-3, characterized in  
20 that the welded parcel (2) consists of a number of square tubes.
5. A method as claimed in any of the preceding claims,  
characterized in that the tubes are straight and/or parallel  
with each other.
- 25 6. A method as claimed in claims 1-3, characterized in  
that the casting is performed at different levels.
7. A method as claimed in any of the preceding claims,  
30 characterized in that the casing (9) consists of steel SS 1306.

FIG. 1

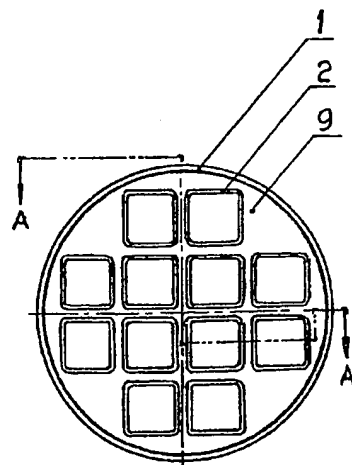
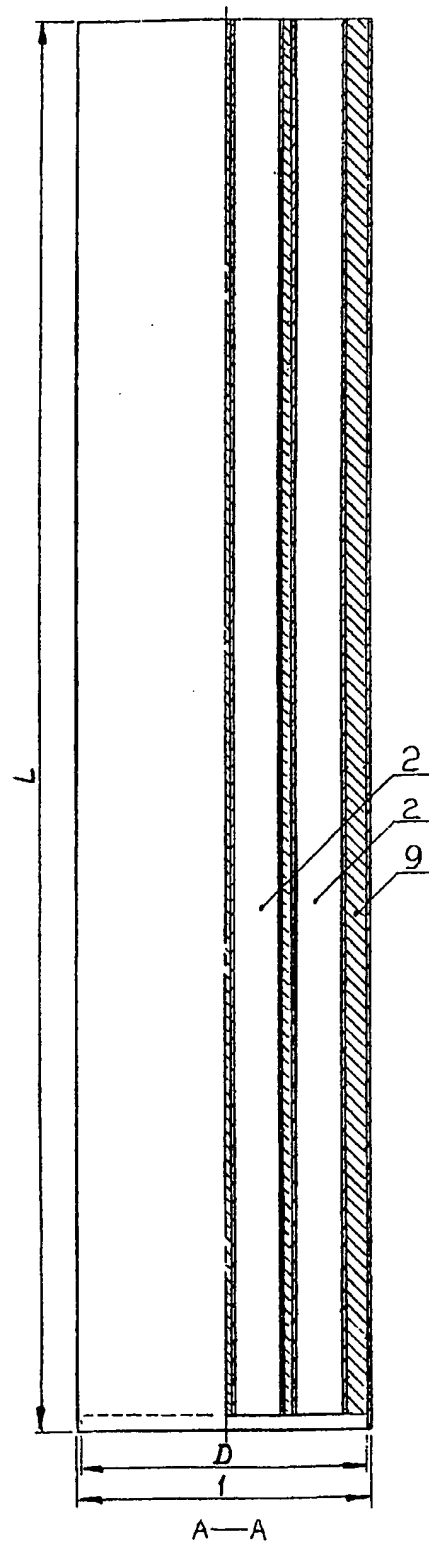
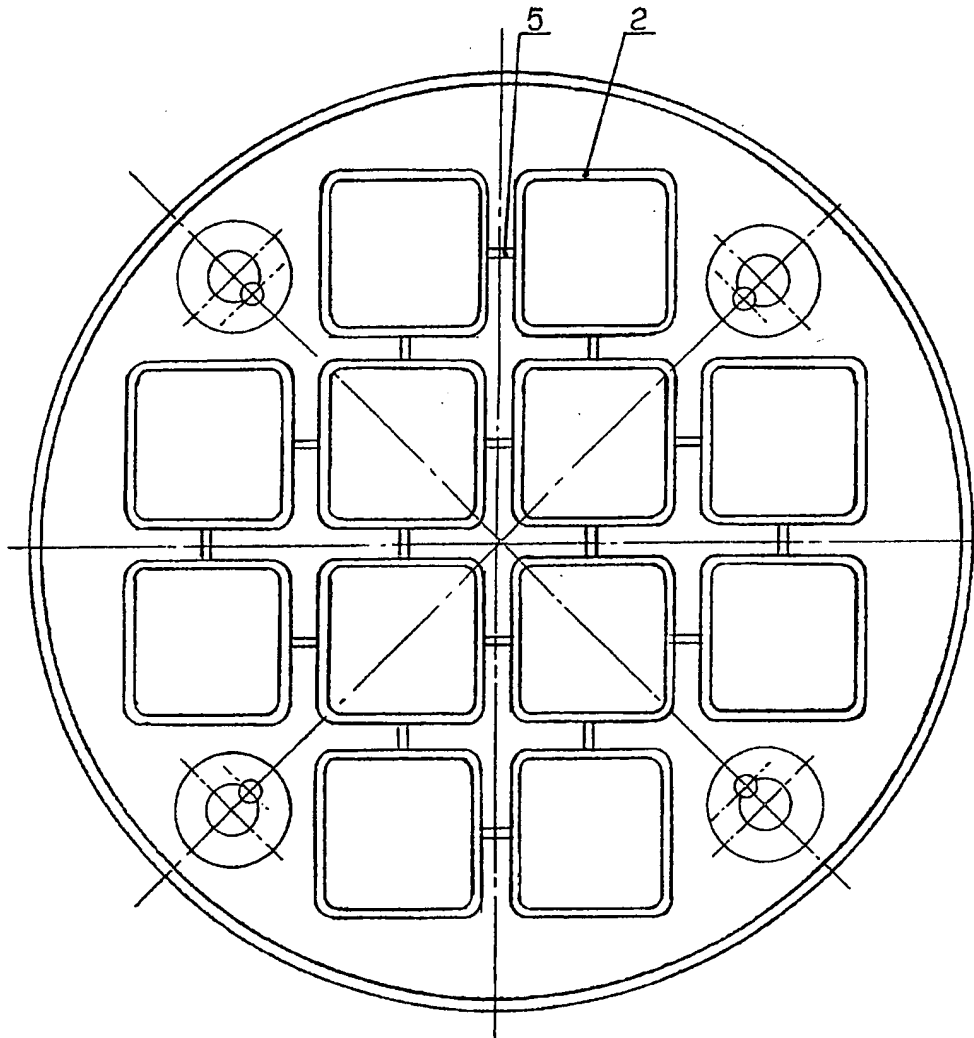


FIG. 2



FIG. 3



# INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 97/01658

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
<b>IPC6: G21F 5/005</b> According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
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<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9526030 A1 (TRANSNUCLEAIRE S.A.), 28 Sept 1995 (28.09.95), figures 1-4, abstract --	1-7
A	DE 3140020 A1 (KERNFORSCHUNGSZENTRUM KARLSRUHE GMBH), 21 April 1983 (21.04.83), figures 1,2, abstract --	1-7
A	WO 9526029 A1 (TRANSNUCLEAIRE), 28 Sept 1995 (28.09.95), figure 1, abstract --	1-7
A	US 5550882 A (LEHNERT ET AL), 27 August 1996 (27.08.96), figure 1, abstract -- -----	1-7
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9526030 A1	28/09/95	DE 663706 T DE 69500741 D EP 0663706 A,B EP 0752151 A ES 2079340 T FR 2715004 A,B JP 7235349 A US 5611707 A ZA 9502084 A	02/05/96 00/00/00 19/07/95 08/01/97 16/01/96 13/07/95 05/09/95 18/03/97 12/03/96
DE 3140020 A1	21/04/83	FR 2514545 A,B GB 2109984 A,B JP 58072100 A	15/04/83 08/06/83 28/04/83
WO 9526029 A1	28/09/95	CZ 9602744 A EP 0752150 A FR 2717945 A,B ZA 9502420 A	15/01/97 08/01/97 29/09/95 16/01/96
US 5550882 A	27/08/96	AU 7972694 A CN 1117322 A EP 0673541 A FI 952817 A JP 8507382 T US 5438597 A WO 9510838 A ZA 9407869 A	04/05/95 21/02/96 27/09/95 08/06/95 06/08/96 01/08/95 20/04/95 09/04/96